Space Weather Technical Forecast

Issued on Friday, 22 July 2022 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storms likely today (22nd) and expected tomorrow (23rd), with a chance of G2/Moderate storms tomorrow. Slight chance of M-flares (R1-R2 Radio blackouts) throughout. Chance of Active electron fluence day 4 (25th). Earth-directed CME expected early tomorrow.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the last 24 hours. There are currently eight active sunspot regions on the visible disc. However, none currently display any significant geomagnetic complexity, or have shown any significant change in spot size or area, only producing frequent C-class flares. The largest of these was from AR3056, which is now just behind the west limb, with a C6.1 flare at 21/2346UTC. An earlier C5.7 from AR3060 triggered a filament eruption, this can be observed in SDO/AIA 304 imagery, which produced a complex CME, with a full halo. This CME has been since been analysed as being Earth directed. No other Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, was steady at background levels with speeds near 370km/s until around 21/1600 UTC, when a small increase occurred and the solar wind reached slightly elevated levels. The solar wind peaked at 466 km/s at 21/1658 UTC. Density was initially at average levels then showed a steady rise to above average, peaking at 34 ppcc. The IMF (interplanetary magnetic field) Bt was mainly at moderate levels until 21/1441 UTC, then became strong, peaking at 21 nT at 21/1631 UTC. Later in the day the IMF declined back to moderate levels again. The north-south component (Bz) was initially unremarkable and mostly positive, but from 21/1400 UTC started fluctuating, ranging between +19 nT and -17 nT at 21/1527 UTC. The phi angle was largely negative (towards the Sun). These solar wind parameters are believed to indicate the arrival of a high speed stream, from one or more coronal holes. The net result was initial Quiet (Kp 1-2) geomagnetic activity increasing to reach G1/Minor storm (Kp 5) levels between 21/1500-2100 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at background levels. High energy electron flux was mainly at moderate levels, but twice briefly breached the High threshold, peaking at 1230 pfu at 21/ 1730 UTC. The corresponding 24-hour integrated electron fluence remained below the Active threshold, with an initial rising trend, followed by a declining trend. The fluence reached 3.544e7 integrated pfu at 22/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Despite a large number of active regions, activity is expected to remain predominantly Low, with a slight chance of isolated M-flares through the period.

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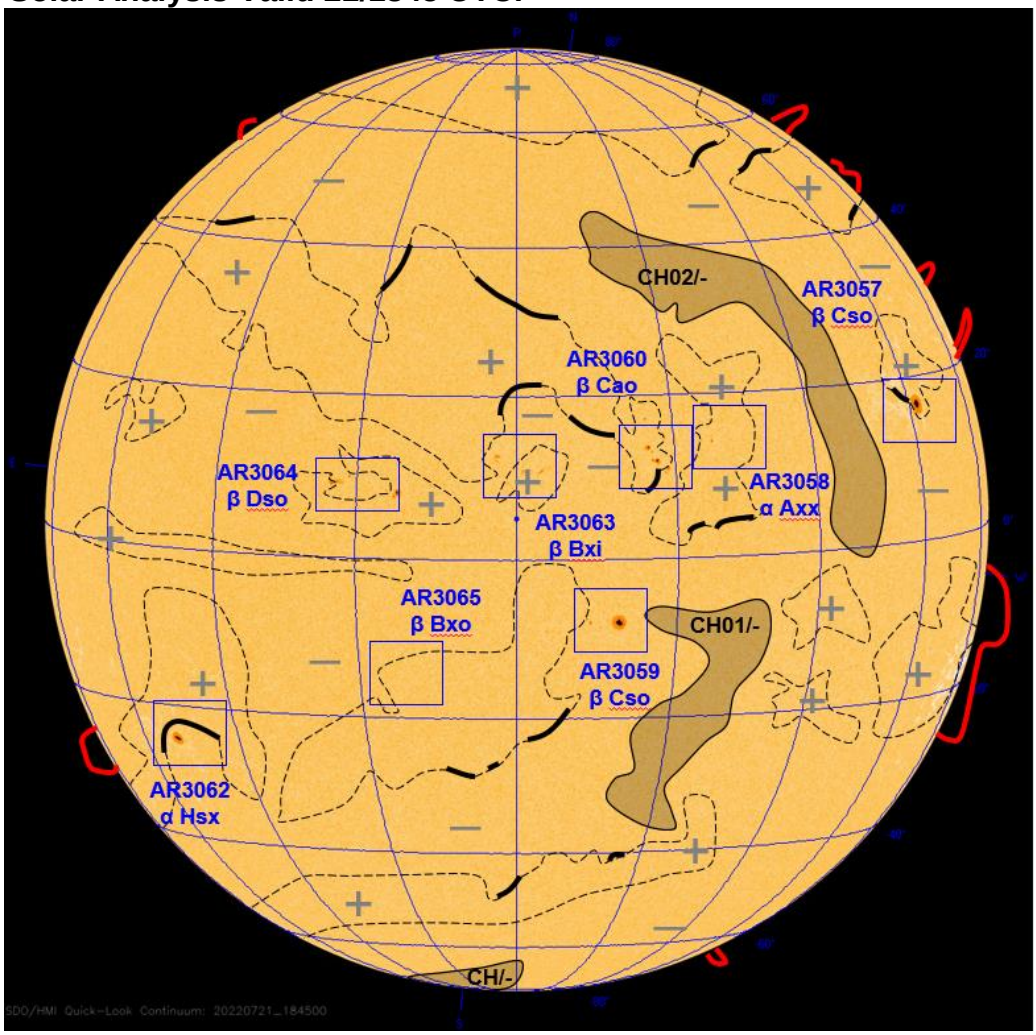
Solar Wind / Geomagnetic Activity: Initially a weak high speed stream (HSS) environment is expected. Then either late today, or more likely early tomorrow, an Earth-directed CME is expected to arrive. This was emitted following a filament eruption near AR3060, and so near centre disc, early on the 21st. Geomagnetic activity is expected to be Unsettled to Active (Kp 3-4) for much of today, due to the HSS effects, with a chance of isolated G1/Minor Storm (Kp 5) intervals at first. With the CME arrival tomorrow (23rd) G1/Minor Storms (Kp 5) are expected to develop, with isolated G2/Moderate (Kp 6) geomagnetic storm intervals likely. During days 3 and 4 (24th and 25th) a gradual decline in activity is expected, reaching Quiet to Unsettled (Kp 2-3) conditions by late day 4.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels. The high energy electron flux (greater than 2 MeV) is expected to be at background to moderate levels today and tomorrow (22nd and 23rd) then increase to temporarily reach High levels day 3 (24th) at the peak of the diurnal cycle, before probably reaching moderate to high levels for day 4 (25th). The associated fluence may rise above the Active threshold (1e8 integrated pfu) later day 4 (24th).

Figure 1. Solar Analysis Valid 21/1845 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Initially a weak high speed stream (HSS) environment is expected, from a combination of coronal hole influence from CH01/- and CH02/-. Then either late today, or more likely early tomorrow, an Earth-directed CME is expected to arrive. This was emitted following a filament eruption near AR3060, and so near centre disc, early on the 21st. There is moderate to high confidence that the CME will be Earth-directed, but slightly lower confidence for the arrival time, with some ensemble forecast model members showing potential arrival late today, and also later tomorrow morning.

Geomagnetic activity is expected to be Unsettled to Active (Kp 3-4) for much of today, due to the HSS effects, with a chance of isolated G1/Minor Storm (Kp 5) intervals at first. With the CME arrival most likely tomorrow (23rd) G1/Minor Storms (Kp 5) are expected to develop, with isolated G2/Moderate (Kp 6) geomagnetic storm intervals likely. There is also a slight chance of G3/Strong (Kp 7) geomagnetic storms occurring. During days 3 and 4 (24th and 25th) a gradual decline in activity is expected, reaching Quiet to Unsettled (Kp 2-3) conditions by late day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	60	80	20	10
Strong	G3	No	1	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Figure 2: Latest MOSWOC Enlil and Ensembles

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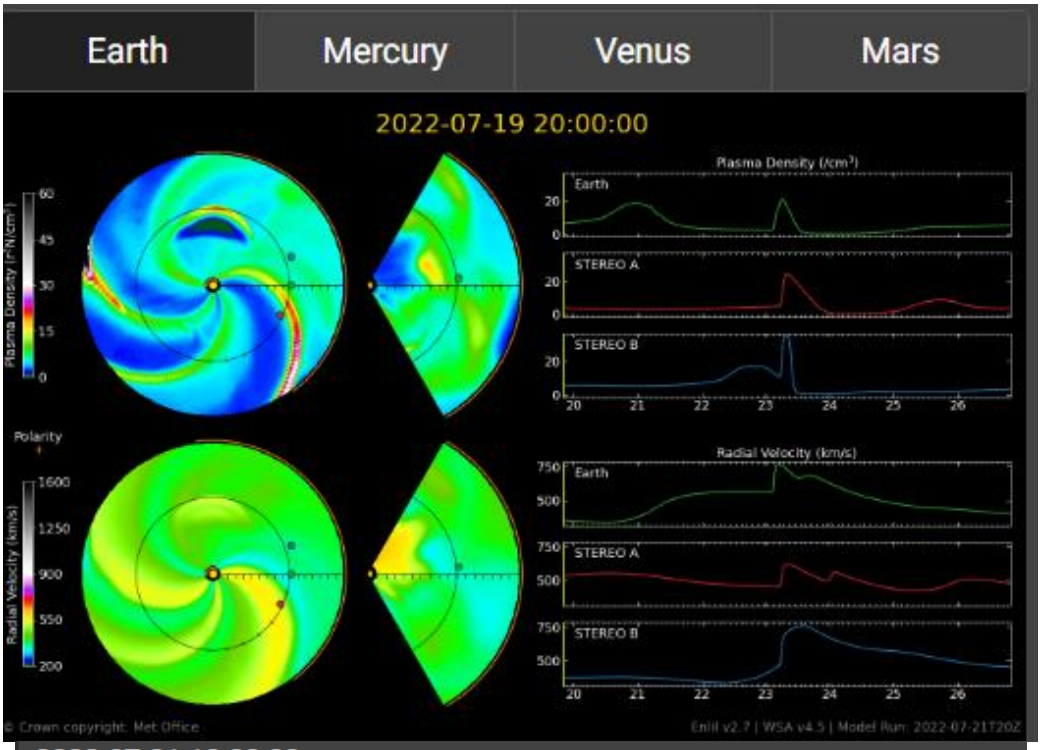

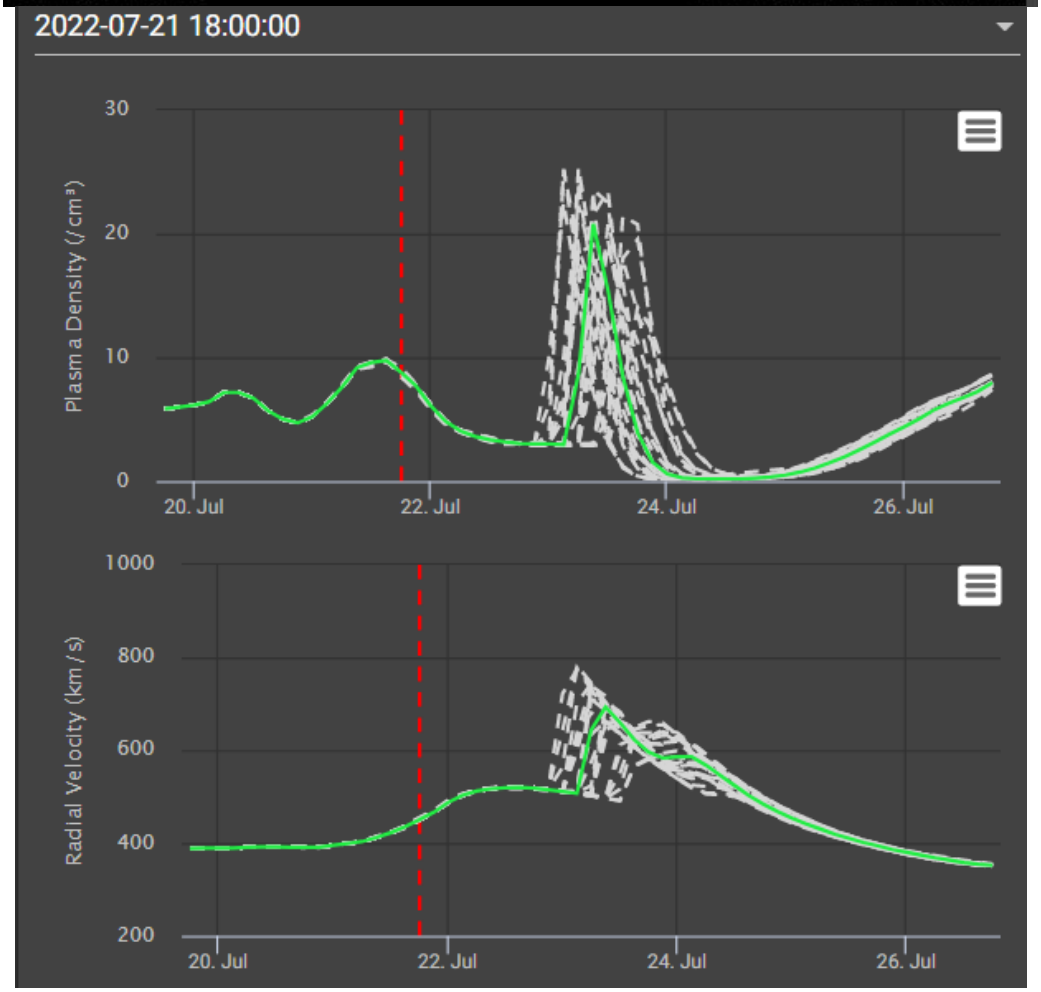

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Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours. There are currently eight active sunspot regions on the visible disc. However, none currently display any significant geomagnetic complexity, or have shown any significant change in spot size or area, only producing frequent C-class flares. The largest of these was from AR3056, which is now just behind the west limb, with a C6.1 flare at 21/2346UTC. An earlier C5.7 from AR3060 triggered a filament eruption, this can be observed in SDO/AIA 304 imagery, which produced a complex CME, with a full halo. This CME has been since been analysed as being Earth directed. No other Earth-directed CMEs were observed.

There are currently eight numbered sunspot regions on the visible disc. All of the regions are magnetically simple, and have not shown any recent significant changes in size or spot number. AR3057 remains the largest region. A region in the southeast, a simple bipolar region, has been numbered as AR3065. Through the period a new region may rotate onto the visible disc from the far side.
Despite a large number of active regions, activity is expected to remain largely Low with an ongoing slight chance of isolated M-flares through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. There is the potential for proton flux increasing due to the number of sunspot regions on the Earth-facing disc, including regions on or just over the west limb. However, these only give a very slight chance of proton flux reaching the S1 level (10 pfu).

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	2	2
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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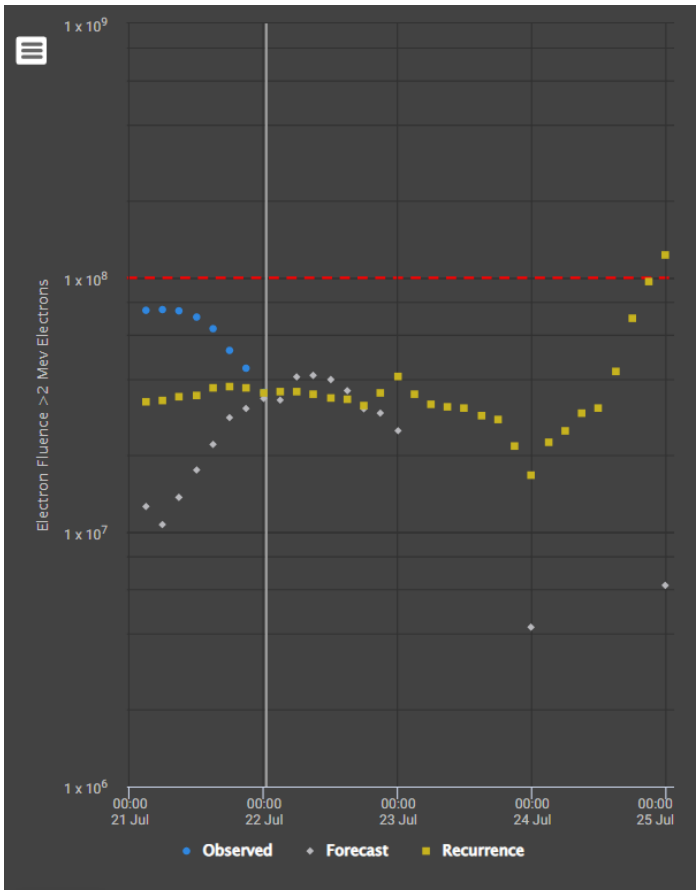
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2 MeV) is expected to be at background to moderate levels today and tomorrow (22nd and 23rd) then increase to temporarily reach High levels day 3 (24th) at the peak of the diurnal cycle, before probably reaching moderate to high levels for day 4 (25th). The associated fluence is may rise above the Active threshold (1e8 integrated pfu) later during day 4 (24th).

Therefore the Met Office REFM model is not considered to give good guidance on this occasion, for the end of the forecast period. The

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	20	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	10

Figure 3: Met Office REFM model.



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